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Cumulative degree-days for estimating peak occurrence of fourth instar larvae of the Spruce Budworm

K.P. Lim

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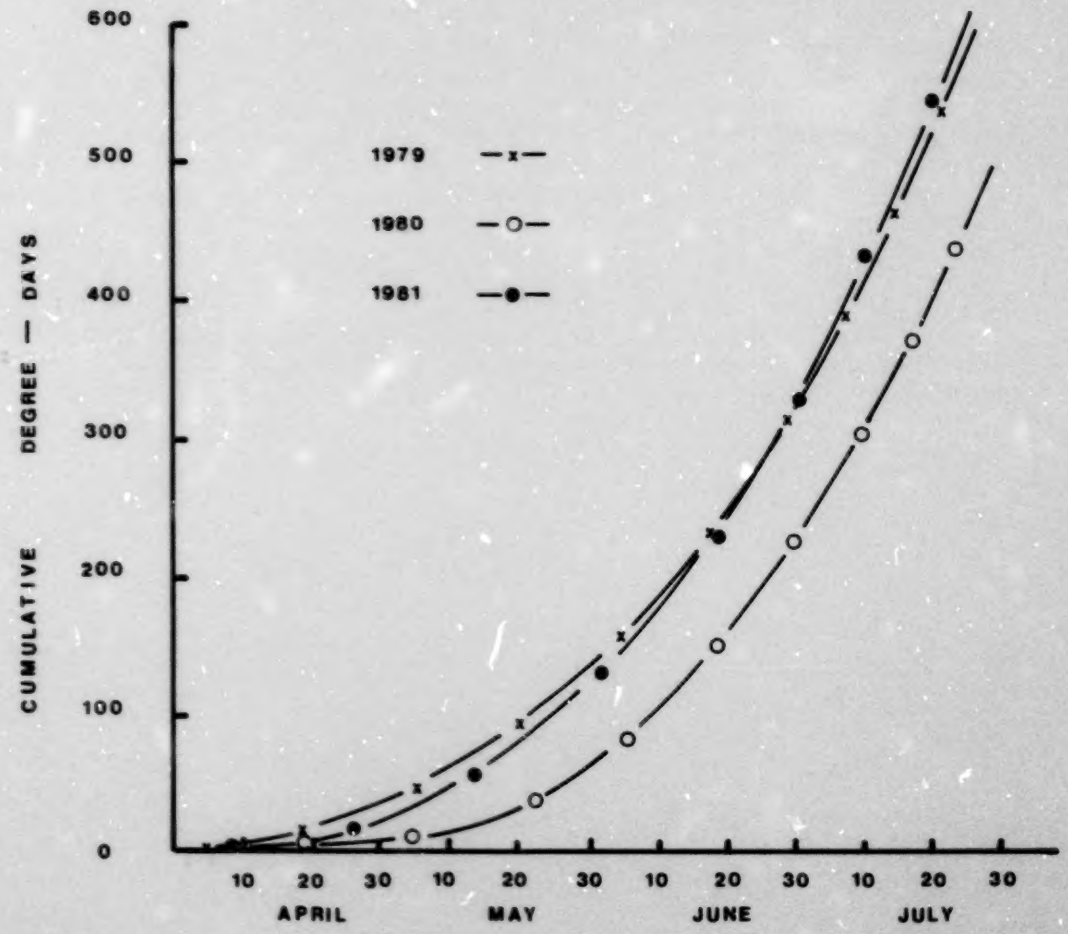
Newfoundland Forest Research Centre



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CUMULATIVE DEGREE-DAYS FOR ESTIMATING PEAK OCCURRENCE OF FOURTH INSTAR LARVAE OF THE SPRUCE BUDWORM, *CHORISTONEURA FUMIFERANA* (LEPIDOPTERA: TORTRICIDAE)

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ABSTRACT

A cumulative degree-days method is used to estimate the peak occurrence of fourth instar larvae of the spruce budworm, Choristoneura fumiferana (Clemens). This peak occurs approximately 204 degree-days accumulated above a threshold of 5.5°C from 1 April.

RÉSUMÉ

Une méthode cumulative de degrés-jours a été utiliseé pour estimer le pic du quatrième âge larvaire de la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clemens). Pour atteindre ce pic, il nécessite 204 degrés-jours accumulés au-dessus de 5.5°C à partir du 1er avril.

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INTRODUCTION

The spruce budworm, Choristoneura fumiferana (Clem.), is a severe defoliator of spruce-fir forests in eastern North America. Third and fourth instar larvae feed on the flushing buds of balsam fir. These larvae are susceptible to applied insecticides through direct contact or subsequent ingestion of the insecticide deposited on the new foliage (Blais 1977). A reliable estimate of larval development is essential to properly time the application of insecticides over large areas. Currently, development of the spruce budworm is monitored by frequent field collections and examination of branch samples from balsam fir during spring. An alternative method is needed because this procedure is extremely expensive over a large area. Degree-days (^{o}D) accumulated above a threshold temperature can be used for predicting the development of various insects (Sevacherian et al. 1977, Eckenrode et al. 1975, Ali Niazee 1975, Eklund and Simpson 1977, Ives 1973, Reissig et al. 1973). Recently, a process oriented model of phenology for the spruce budworm was developed (Régnière 1982). This report describes the heat accumulation method to predict the peak occurrence of fourth instar larvae of the spruce budworm.

MATERIALS AND METHODS

Spruce budworm larvae were collected three times weekly at Donovans near St. John's on balsam fir, Abies balsamea (L.) Mill., from late May to late July during 1979, 1980 and 1981. Samples were preserved in 75% alcohol immediately after collection and were classified by various instar (McGugan 1954). Samples collected within each week were pooled to determine the ratio of each developmental stage. Cumulative degree-days were calculated based on the formulae of Lindsey and Newman (1956). Cumulative degree-days began each year on the first of April and a base temperature of 5.5°C (42°F) was used as suggested by Miller et al. (1971).

RESULTS AND DISCUSSION

Comparison of the cumulative degree-days of 1979, 1980 and 1981 revealed similar patterns for 1979 and 1981 (Fig. 1). In 1980, there was at least a two week delay in reaching the same level of cumulative degree-days compared to the other two years. In 1979, peak development of fourth instar larvae (L_4) occurred during the week of 13 June (Table 1) with 204.13 degree-days. In 1980, due to the cool weather in the early growing season, development of the spruce budworm was delayed and the peak of L_4 occurred during the week of 25 June with 206.25 degree-days. In 1981, the same event occurred during the week of 10 June with 203.33 degree-days. The mean cumulative degree-days for peak occurrence of L_4 for these three years was 204.57 $\pm$ 1.51.

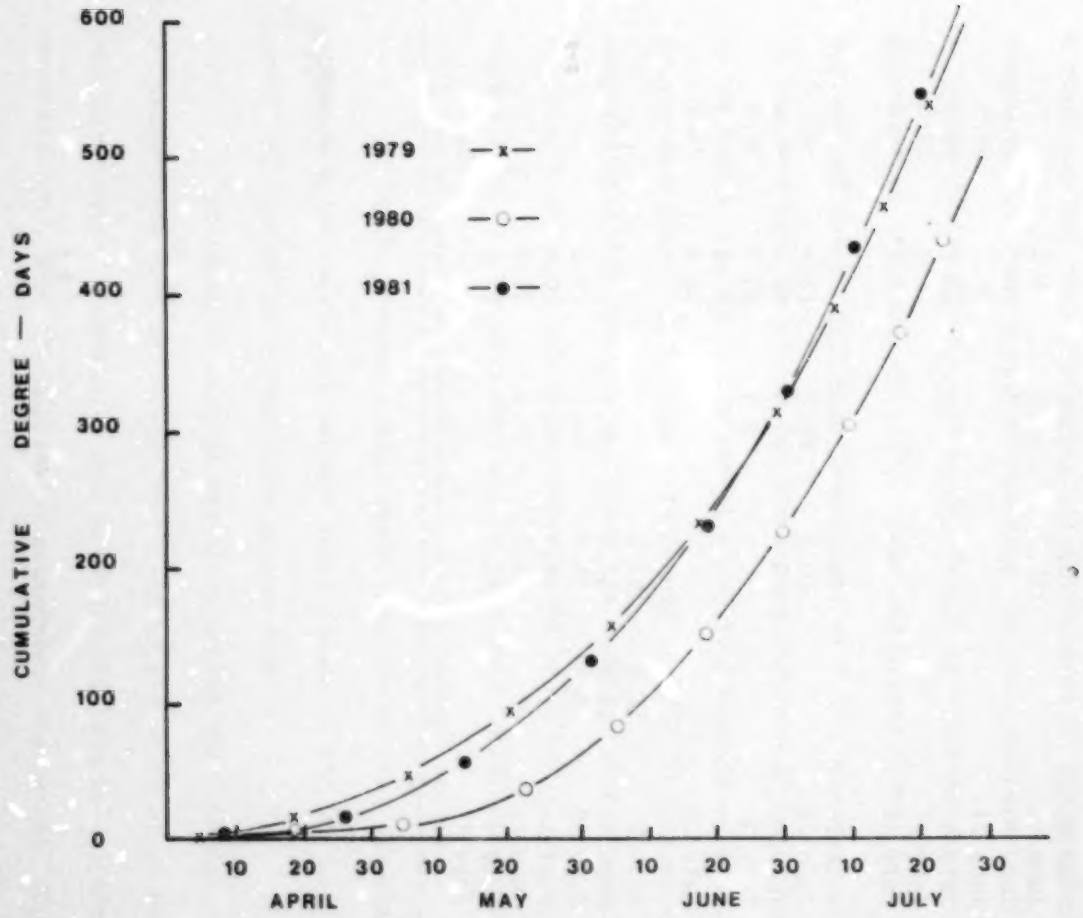

Fig. 1. Cumulative degree-days with the threshold temperature of 5.5°C at St. John's, 1979 to 1981 inclusive.

Table 1. Development of the spruce budworm on balsam fir at Donovans, St. John's during 1979, 1980 and 1981.

Year	Date	% of Population				
		L_2	L_3	L_4	L_5	L_6
1979	June 6		90.2	9.8		
	June 13		21.7	69.3	9.0	
	June 20		6.3	7.3	74.5	11.9
	June 27				31.1	68.9
	July 4				20.0	80.0
	July 11				11.0	89.0
	July 18				10.2	89.8
1980	June 18		90.2	9.8		
	June 25		10.9	64.8	21.9	2.3
	July 2		0.4	11.5	81.6	6.4
	July 9			2.3	60.8	36.9
	July 16				37.8	62.2
	July 23				25.8	74.2
1981	May 27	16.6	83.3			
	June 3	22.4	56.9	20.7		
	June 10	6.2	25.0	43.7	25.0	
	June 17		46.7	33.3	20.0	
	June 24		53.7	24.4	21.9	
	July 1		62.5		37.5	
	July 8					100.0

Few reports exist on the effect of temperature in relation to development of the spruce budworm. Henson (1948) reported that an air temperature of 42°F is the threshold temperature of movement for second instar larvae. Rose and Blais (1954) noted that the emergence of second instar larvae from the hibernacula was closely related to the April and May temperatures. Bean (1961) stated that the approximate date of emergence of second instar larva could be determined by accumulating degree-hours above a base threshold of 2.5°C. Bean and Wilson (1964) felt that day degrees summation, with base temperature of 2.5°C, was the most practical of the four methods tested for predicting the date of which the peak of third instar occurred. Cameron et al. (1968) calculated cumulative degree-days from 1 April with a threshold of 37°F (2.5°C) to set the sampling date for population studies and chemical control operations. However, results of laboratory experiments by Miller et al. (1971) showed 42°F (5.5°C) as a more appropriate base temperature for predicting the emergence of post-diapause spruce budworm larvae.

In the present study, the occurrence of other developmental stages was not consistent between years (Table 1) and was not considered practical for use with cumulative degree-days.

For chemical control operation within the Province, a network of temperature monitoring stations could be set up in areas with high egg mass counts. Cumulative degree-days could then be calculated for each station. When the cumulative degree-days approaches 200, field samples could be taken to check for the development of the spruce budworm. This could reduce the frequencies of samples taken during the spring and make the timing of control treatment more efficient.

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